Next Generation Science Standards 101 and Middle Grades Webinar

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October 16, 2013

CALIFORNIA DEPARTMENT OF EDUCATION
Tom Torlakson, State Superintendent of Public Instruction

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State Superintendent
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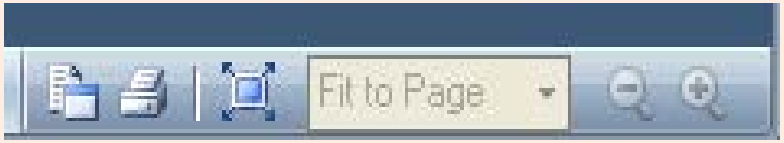
Next Generation Science Standards 101 and Middle Grades Webinar
October 16, 2013
3:00 – 4:00 p.m.

- **For audio, dial 1-650-479-3207 Code 669 156 610**
- **Please place your phone on mute. Use *6 if you do not have a mute button.**
- **Questions will be taken after the presentations.**
- **Screen settings vary. Scrolling might be necessary.**



Use the controls at the bottom of the screen for viewing size.

NGSS
Setting a New Course

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Development of the NGSS

- Achieve, Inc. convened 26 states during the last two years to develop the NGSS.
- California State Board of Education unanimously adopted NGSS for California Kindergarten through Grade Twelve.

Let’s take a look at the Standards

Building on the Past; Preparing for the Future

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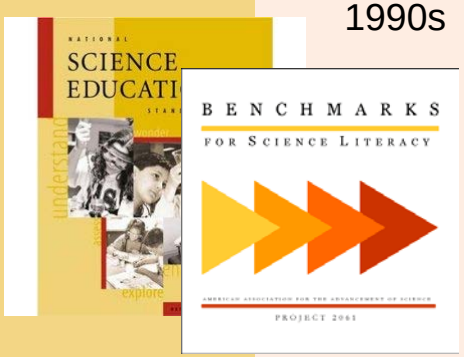
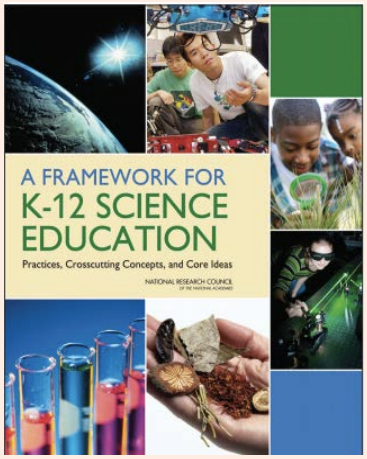
Phase I

Phase II

1990s



1990s-2009



1/2010 - 7/2011

NEXT GENERATION SCIENCE STANDARDS
For States, By States

7/2011 – April 2013

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Conceptual Shifts in the NGSS

1. K-12 science education should reflect the interconnected nature of science as it is practiced and experienced in the real world.

2. The Next Generation Science Standards are student performance expectations – NOT curriculum.

3. NGSS focuses on enduring Disciplinary Ideas, rather than isolated science facts.

4. The science concepts build coherently from K-12.

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Conceptual Shifts in the NGSS (cont.)

5. The NGSS focus on deeper understanding of content as well as application of content.

6. Science and Engineering are Integrated in the NGSS from K–12.

7. The NGSS are designed to prepare students for college, career, and citizenship.

8. The NGSS and Common Core State Standards (English language arts and Mathematics) are aligned.

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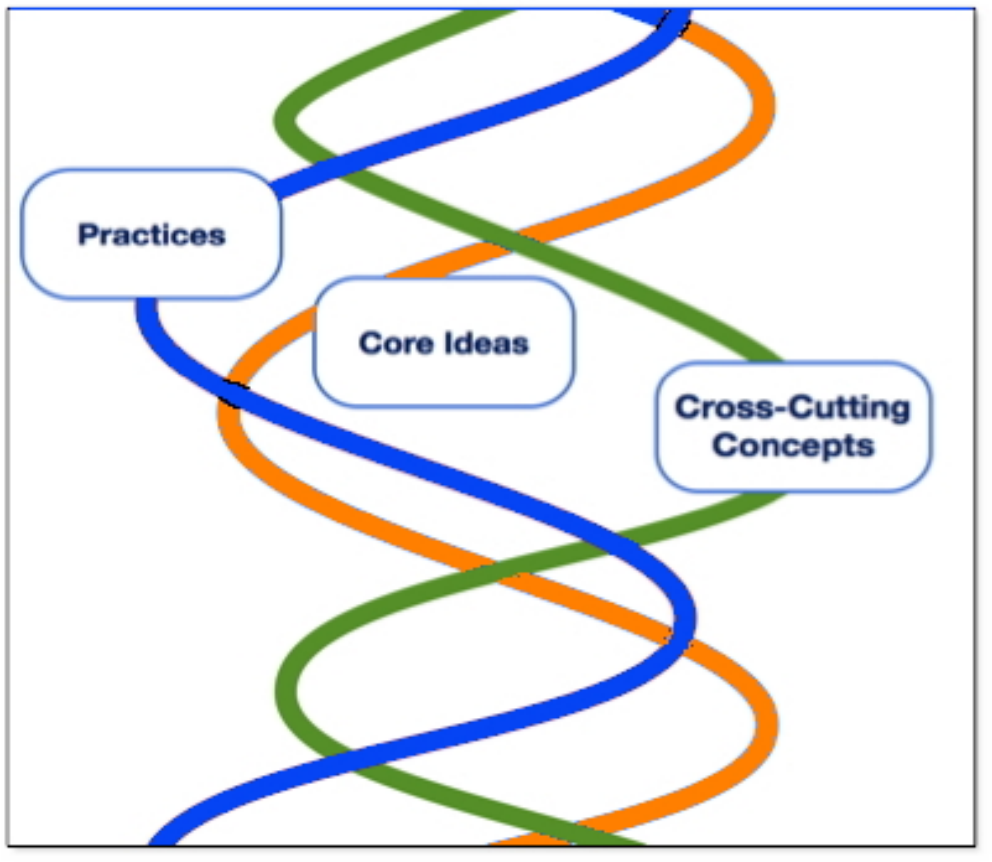
Three Dimensions Intertwined



- The NGSS are written as Performance Expectations
- NGSS will require contextual application of the three dimensions by students
- Focus is on how and why as well as what

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5.Matter and Energy in Organisms and Ecosystems

5.Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

5-PS3-1. **Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.** [Clarification Statement: Examples of models could include diagrams, and flow charts.]

5-LS1-1. **Support an argument that plants get the materials they need for growth chiefly from air and water.** [Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.]

5-LS2-1. **Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.** [Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.] [Assessment Boundary: Assessment does not include molecular explanations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
- Use models to describe phenomena. (5-PS3-1)
- Develop a model to describe phenomena. (5-LS2-1)

Engaging in Argument from Evidence
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).
- Support an argument with evidence, data, or a model. (5-LS1-1)

Connections to Nature of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Science explanations describe the mechanisms for natural events. (5-LS2-1)

Disciplinary Core Ideas

PS3.D: Energy in Chemical Processes and Everyday Life
- The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)

LS1.C: Organization for Matter and Energy Flow in Organisms
- Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary to 5-PS3-1)*
- Plants acquire their material for growth chiefly from air and water. (5-LS1-1)

LS2.A: Interdependent Relationships in Ecosystems
- The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)

Crosscutting Concepts

Systems and System Models
- A system can be described in terms of its components and their interactions. (5-LS2-1)

Energy and Matter
- Matter is transported into, out of, and within systems. (5-LS1-1)
- Energy can be transferred in various ways and between objects. (5-PS3-1)

Connections to other DCIs in fifth grade: **5.PS1.A** (5-LS1-1),(5-LS2-1); **5.ESS2.A** (5-LS2-1)

Articulation of DCIs across grade-levels: **K.LS1.C** (5-PS3-1),(5-LS1-1); **2.PS1.A** (5-LS2-1); **2.LS2.A** (5-PS3-1),(5-LS1-1); **2.LS4.D** (5-LS2-1); **4.PS3.A** (5-PS3-1); **4.PS3.B** (5-PS3-1); **4.PS3.D** (5-PS3-1); **4.ESS2.E** (5-LS2-1); **MS.PS3.D** (5-PS3-1),(5-LS2-1); **MS.PS4.B** (5-PS3-1); **MS.LS1.C** (5-PS3-1),(5-LS1-1),(5-LS2-1); **MS.LS2.A** (5-LS2-1); **MS.LS2.B** (5-PS3-1),(5-LS2-1)

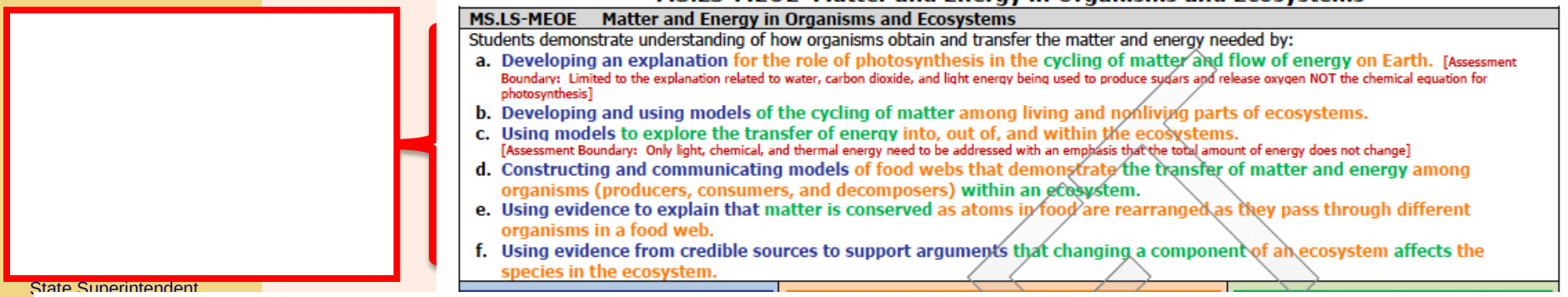
Common Core State Standards Connections:

ELA/Literacy –

RI.5.1	Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. *(5-LS1-1)*
RI.5.7	Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. *(5-PS3-1),(5-LS2-1)*
RI.5.9	Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-LS1-1)
W.5.1	Write opinion pieces on topics or texts, supporting a point of view with reasons and information. (5-LS1-1)
SL.5.5	Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-PS3-1),(5-LS2-1)*

Mathematics –

MP.2	Reason abstractly and quantitatively. *(5-LS1-1),(5-LS2-1)*
MP.4	Model with mathematics. *(5-LS1-1),(5-LS2-1)*
MP.5	Use appropriate tools strategically. *(5-LS1-1)*
5.MD.A.1	Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. *(5-LS1-1)*



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a) Stem: Each standard is written in the form of one sentence, that identifies the disciplinary core idea, the scientific practice and the crosscutting concept the student is expected to demonstrate at the end of instruction..

b) The clarification statements provide a short description of a nuance of the standard

c) The assessment boundary provides the depth of understanding all students are expected to demonstrate.

Foundation boxes provide information that expands and explains the standard statements in relation to the three dimensions:

Foundation Boxes

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models ▪ Use models to explore relationships between variables, especially those representing input and output. (b),(c),(d) ▪ Use various representations and models (including computer simulations) to predict, explain, and test ideas about phenomena in a natural or designed system. (b),(c),(d) **Constructing Explanations and Designing Solutions** ▪ Generate and revise causal explanations from data (e.g. observations and sources of reliable information) and relate these explanations to current knowledge. (a) ▪ Base explanations on evidence and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e) **Engaging in Argument from Evidence** ▪ Use arguments and empirical evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)	**LS1.C: Structure and Function** ▪ Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (a) ▪ Animals obtain food from eating plants or eating other animals. (d),(e) ▪ Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth or to release energy. (e) ▪ In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce waste carbon-dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not need oxygen. (c) **LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** ▪ Food webs are models that demonstrate how matter and energy is transferred between producers (generally plants and other organisms that engage in photosynthesis), consumers, and decomposers as the three groups interact—primarily, for food—within an ecosystem. (d) ▪ Transfers of matter into and out of the physical environment occur at every level. For example when molecules from food react with oxygen captured from the environment, the carbon dioxide and water thus produced are transferred back to the environment, and ultimately so are waste products, such as fecal matter. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (b),(c),(d) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ▪ Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)	**Systems and System Models** ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (b),(c),(d) ▪ Models are limited in that they only represent certain aspects of the system under study. (b),(c) **Energy and Matter** ▪ Matter is conserved because atoms are conserved in physical and chemical processes. This conservation of atoms helps explain the cycling of matter in nature. (b),(e) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (c),(d) ▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a) **Stability and Change** ▪ Small changes in one part of a system might cause large changes in another part. (f)

Connections to other topics in this grade-level: **MS.ESS-HE, MS.ESS-ESP, MS.PS-SPM, MS.PS-ECT, MS.PS-CR**

Articulation across grade-levels: **3.SFS, 5.MEE, HS.LS-MEOE, HS.LS-IRE**

Common Core State Standards Connections:

ELA –

W.6.8 Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources.

W.7.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

W.8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

Connection boxes provide:

a) connections to other topics in a particular grade level.

b) articulation across grade levels.

c) connections to Common Core State Standards (CCSS).

assumption that natural laws operate today as they did in the past and will continue to do so in the future. (a),(e)

Engaging in Argument from Evidence

- Use arguments and empirical evidence to construct a convincing argument that supports or refutes a claim made by someone else. (f)

LS2.B: Cycle of Matter and Energy Transfer in Ecosystems

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LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (f)

(c),(d)

- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (a)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (f)

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Mathematics –

MP.3 Construct viable arguments and critique the reasoning of others.

6.SP Summarize and describe distributions

8.F Use functions to model relationships between quantities

Connection boxes

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NGSS Supporting Materials

- Appendices have been added to support the NGSS and in response to feedback
  - Appendix A – Conceptual Shifts
  - Appendix B – Responses to Public Feedback
  - Appendix C – College and Career Readiness
  - Appendix D – All Standards, All Students
  - Appendix E – Disciplinary Core Idea Progressions in the NGSS
  - Appendix F – Science and Engineering Practices in the NGSS
  - Appendix G – Crosscutting Concepts in the NGSS
  - Appendix H – Nature of Science
  - Appendix I – Engineering Design in the NGSS
  - Appendix J – Science, Technology, Society, and the Environment
  - **Appendix K – Model Course Mapping in Middle and High School – Includes California Integrated Model for Grades 6-8**
  - Appendix L – Connections to Common Core State Standards in Mathematics
  - Appendix M – Connections to Common Core State Standards in ELA

Adopted the SBE Septembe 2013

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Moving from Current CA Science Standards to NGSS for California

Less emphasis on	More emphasis on
Discrete facts	Conceptual understanding with a focus on depth over breadth
Isolated investigation and experimentation process skills	Integration of science and engineering practices with content
Student acquisition of information	Student understanding and use of scientific knowledge within and across science disciplines, and science an engineering practices
Numerous standards	Limited number of Disciplinary Core Ideas and Cross Cutting Concepts that unify the study of science and engineering
Uneven articulation throughout grade levels	Learning progressions that develop K-12
No engineering	Engineering standards and practices that all students should encounter
Assessing science knowledge	Assessing scientific understanding and reasoning specified by the performance expectations
Limited correlation with other subjects	Correlation with CCSS ELA and Mathematics
Limited integration of science disciplines in middle school	Integration of science disciplines in middle school

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Grade 5 - Physical Science

California 5th Grade Physical Science

- *Students know* the common properties of salts, such as sodium chloride (NaCl).

NGSS Physical Science- Grade 5

- Make observations and measurements to identify materials based on their properties.

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Grade 7- Life Science

California 7th Grade Life Science

- *Students know the* function of the Umbilicus and placenta during pregnancy.

NGSS Life Science - Middle School

- Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

High School- Earth and Space Sciences

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California High School - Earth Science 1.b

- ***Students know*** **the evidence from Earth and moon rocks indicates that the solar system was formed from a nebular cloud of dust and gas approximately 4.6 billion years ago.**

California Investigation and Experimentation High School

- **1.i. Analyze the locations, sequencing, or time intervals that are characteristic of natural phenomena (e.g. relative ages of rocks, location of planets over time, and succession of species in an ecosystem)**

Or/And

- **1.k. Recognize the cumulative nature of scientific evidence.**

NGSS Earth and Space Science High school

- **Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.**

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Example of Engineering Design Standards Grades K-2

Students who demonstrate understanding can:

- **K-2-ETS1-1.**Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

- **K-2-ETS1-2.**Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

- **K-2-ETS1-3.**Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

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California's Process to Adoption

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California Science Expert Panel (SEP)

- 27 Science Experts who are representative of the SRT
  - K-12 Teachers, COE Science Leaders, IHE Faculty, Business, Industry, and Informal Science Centers
  - Noted Scientist Advisors
    - Dr. Bruce Alberts
    - Dr. Helen Quinn
    - Dr. Art Sussman

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SEP Role

- Review National NGSS to make preliminary recommendations for field comment
- Review feedback from public forums and SRT surveys
- Recommend new California Science Standards based on the NGSS to the Superintendent of Public Instruction
- The SEP met three times during April, May, and June

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SEP April Meeting Recommendations to the Field

- Accept NGSS for California
- Build on current California middle grades semi-integrated standards to integrated standards for grades 6-8.

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What Research Says

- Iowa SS&C: Found significant positive differences in learning in science concepts, process, application, creativity, attitude, and world view of SS&C compared to non-SS&C students. Liu, C., & Yager, R. E. (1997)

- CA SS&C: Students in integrated biology scored the same or better than students in traditional biology on the Golden State Exam. Scott, G (2000)

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Research Continued

Achieve examined 10 sets of international standards (i.e., Canada, Chinese Taipei, England, Finland, Hong Kong, Hungary, Ireland, Japan, Singapore, and South Korea), with the intent of informing the development of both the conceptual framework and new U.S. science standards.

The major key findings include:

- Finding #1 - All countries require participation in integrated science instruction through Lower Secondary, and seven of 10 countries continue that instruction through Grade 10, providing a strong foundation in scientific literacy. Achieve (2010).

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Criteria for Design

PEs must :

- Be arranged to provide a TRANSITION from elementary to high school
- ALIGN with CCSS ELA and Math
- Build WITHIN and ACROSS grade levels
- Be BALANCED in complexity and quantity at each grade
- INTEGRATE engineering appropriately

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Dr. Art Sussman:

"…the SEP very seriously considered the option of having discipline-focused concepts …It quickly became very clear that there had to be foundational physical science concepts in grade 6 to be able to do …life and earth science concepts…. That combination of needing some physical science in grade 6 but not being able to do all physical science in grade 6 made the discipline-specific approach impossible.

Dr. Bruce Alberts

[With this arrangement] the students will reinforce what they learned the previous year, returning to related ideas, and the focus in every year will be on SCIENCE itself, not biology, or earth sciences, or the physical sciences."

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Articulation
One Example

Life Science

- 8th Natural Selection
- 7th Ecosystems
- 6th Cells/Organisms

An Example Integration 7th Grade

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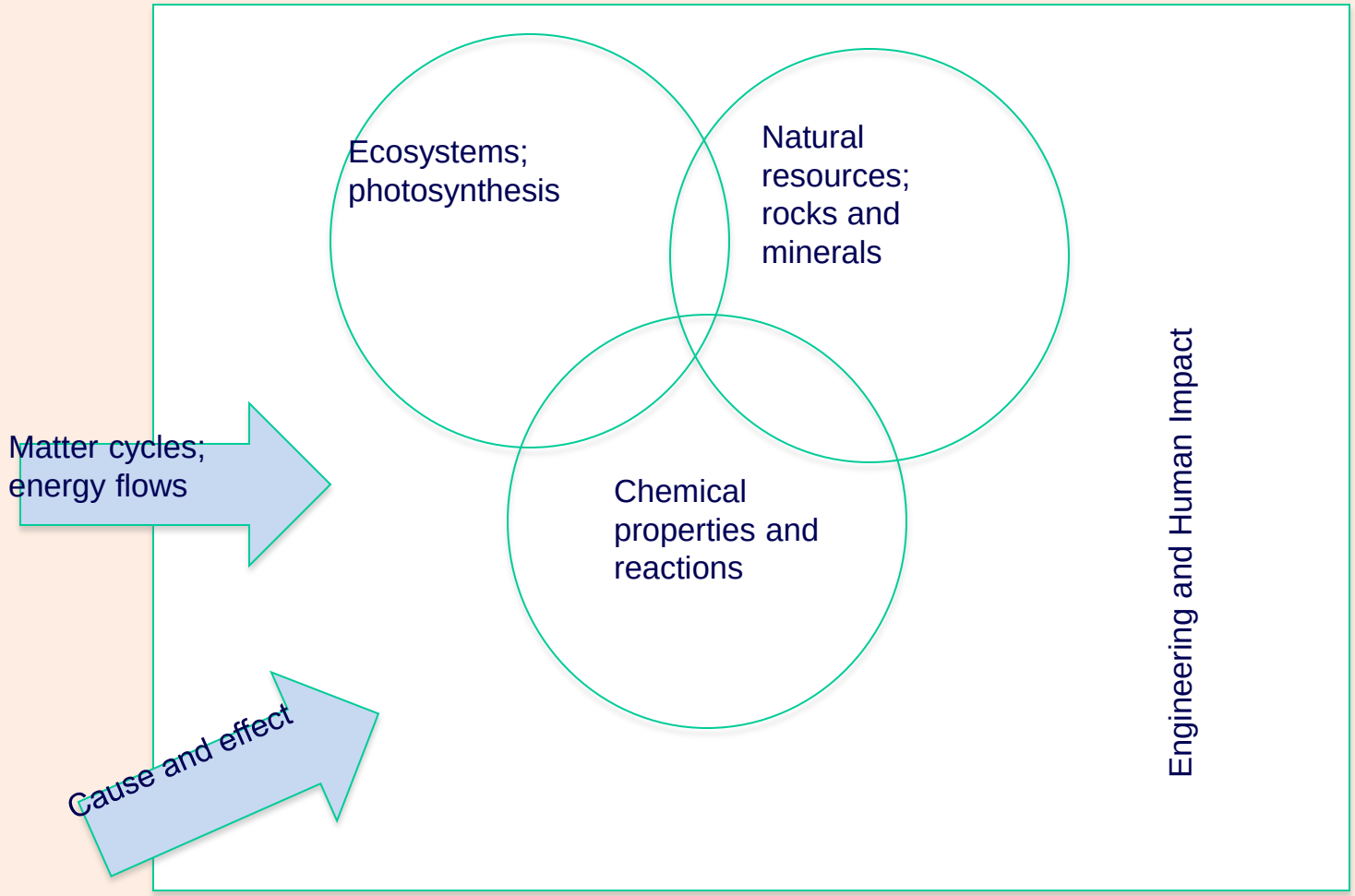

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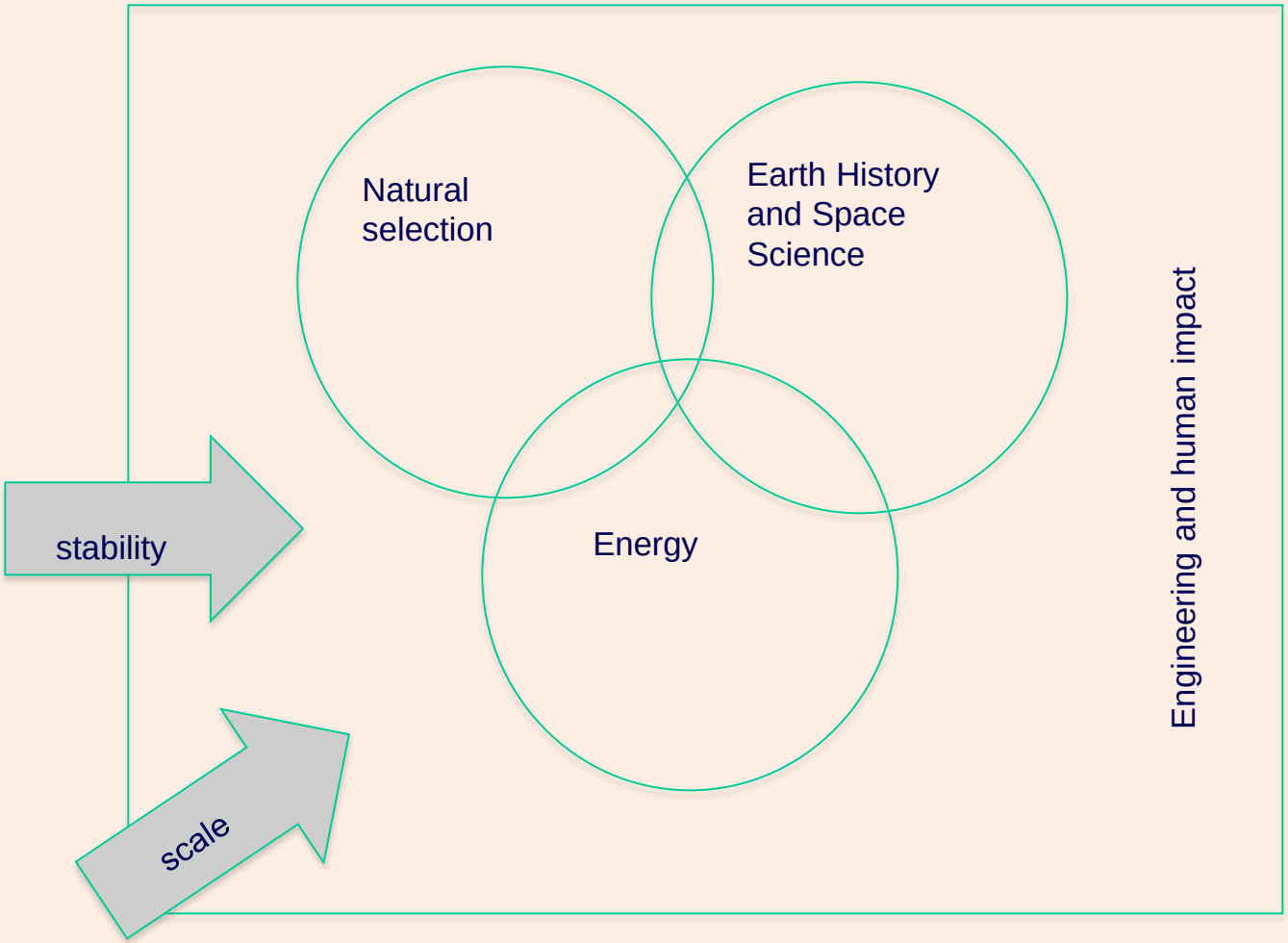
An Example Integration 8th Grade



An Example Integration 6th Grade

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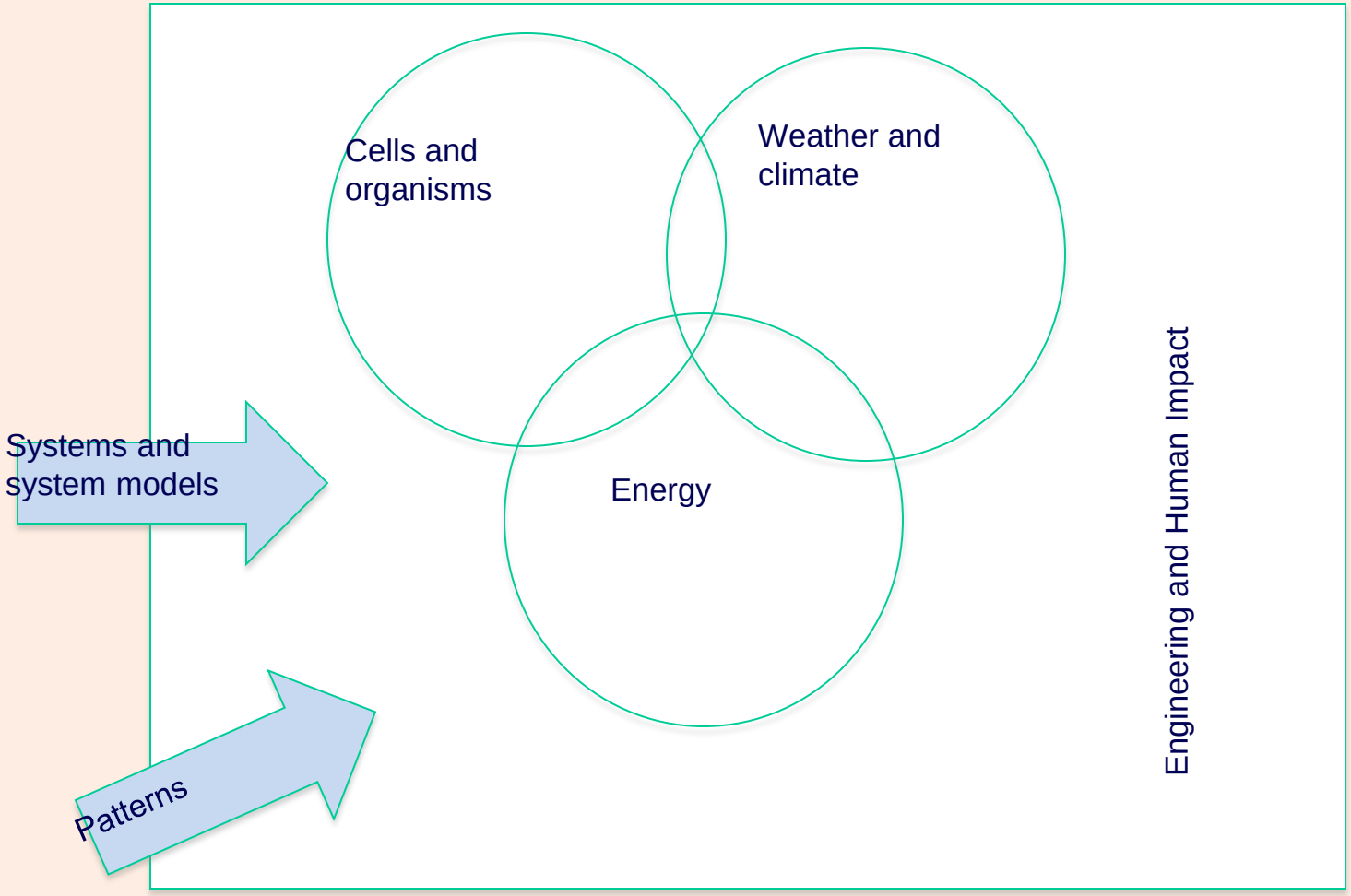

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Dr. Helen Quinn

"The recommended middle school sequence was developed with careful attention to many factors that will enhance student learning, as has been presented elsewhere. The evidence that such interleaved learning of topics, where past learning is connected to, applied and further developed in each subsequent unit or year provides the best opportunity for students to develop deeper understanding and transferrable, that is useable, knowledge. I strongly recommend that this sequence should be adopted. While it presents some challenges for teacher assignments it will in the long run be the most productive for in-depth student learning."

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Pros of Two Choices

Discipline Specific

- Teacher Content Expertise
- Teacher Passion

Integration

- NGSS vision for science not silos
- Implementation of Cross Cutting Concepts
- Possibility of 8th grade integrated assessment
- Articulated Learning progression with LEPE each year
- SEP recommendation

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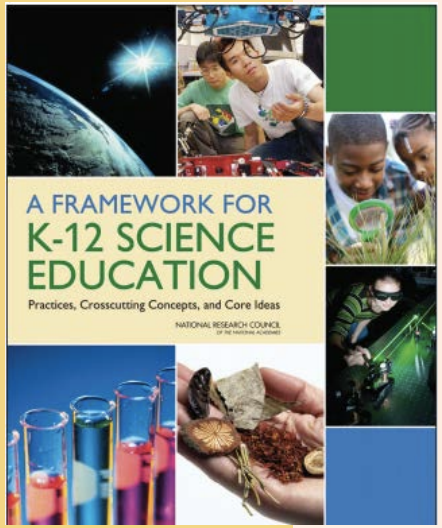
Lots of work completed, underway, and left to do



NEXT GENERATION SCIENCE STANDARDS

- CA Framework
- Assessment
- Instruction
- Teacher Development

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Implementation Timeline

- 2013: Adoption of the CA NGSS
- 2014: CST 5, 8, 10 Science Assessment on current CA Science Standards
- 2014: Science Framework begins
- 2015-2016: Earliest Implementation (more likely 2016-2017)
- 2016-2017: Science Instructional Materials
- ???: Science assessment on CA NGSS

Discovery consists of seeing what everybody has seen -- and thinking what nobody has thought.

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Continued Opportunities to Learn about the CA NGSS

- CDE NGSS web pages
- California Science Teachers Association (CSTA)
- California STEM Learning Network (CSLNet)

California STEM Learning Network

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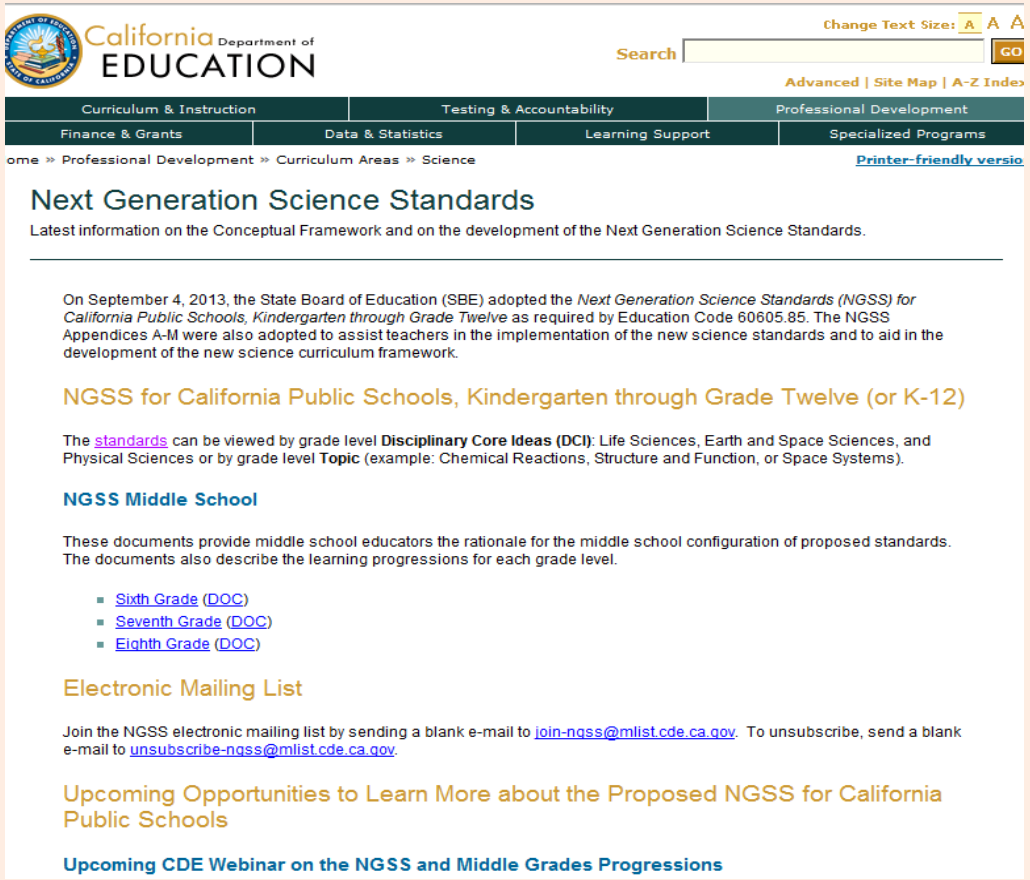
Join the CDE NGSS ListServ



http://www.cde.ca.gov/pd/ca/sc/ngssintrod.asp

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NGSS Input Survey

http://www.surveymonkey.com/s/NGSS-implementation

Your feedback will be shared with the State Board of Education.

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Thank you

NGSS@cde.ca.gov